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ISSN: 0974-4908
Res. Environ. Life Sci.
9(7) 813-818 (2016)

Seed yield, nutrient uptake, quality and economics of mungbean genotypes as influenced by different dates of sowing and foliar nutrition

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(Received: October 15, 2015; Revised received: April 08, 2016; Accepted: April 14, 2016)

Abstract: The experiment was laid out in split- split plot design with 24 treatment combinations consisting of four dates of sowing (14th June, 29th June, 15th July, 30th July), and three genotypes (DGGV-2, IPM-02-14, SEL-4) and foliar spray of 2 per cent DAP and without spray in black soil with a pH of 7.80 under rainfed condition. The early sown of 14th June crop with DGGV-2 and spraying of 2% DAP at flowering and early pod development stage recorded significantly higher net returns Rs.32226 ha^{-1}and B: C ratio of 2.92 and same treatment recorded significantly higher nitrogen, phosphorous and potassium uptake (59.02, 11.90 and 26.16 kg ha^{-1}, respectively) compared to other dates of sowing. The genotype DGGV-2 recorded significantly higher N, P and K uptake (50.89, 11.24 and 23.09 kg ha^{-1}, respectively) over IPM-02-14 (43.39, 10.29 and 21.39 kg ha^{-1}, respectively) and SEL-4 (45.30, 10.59 and 21.42 kg ha^{-1}, respectively). Significant difference was observed in N and P uptake with 2% DAP spray compared no spray. None of the interactions were found to be significant except date of sowing and genotype the D_1V_1 recorded significantly higher N, P and K uptake (64.28, 13.13, 29.14 kg ha^{-1}, respectively).

Key words: Mungbean quality, Date of sowing, Economics

Introduction

Pulses, best known as "poor man's meat", constitute the major source of dietary protein of the large section of vegetarian population of the world. On an average, pulses contain 20 to 30 % protein, which is almost 2.5 to 3.0 times the value normally found in cereals. Besides their high nutritional value, they have a unique characteristic of maintaining and restoring soil fertility through biological nitrogen fixation and thus play a vital role in sustainable agriculture (Asthana, 1998). Pulses occupy an area of 68.32 m. ha and contributes 57.51 m.t to the world food basket (Chaturvedi and Ali, 2002). India is the largest producer and consumer of pulses in the world accounting for 33 % of world area and 22 % of world production. At present, in India the total area under pulses is 228.0 lakh hectares with a total production of 130.7 lakh tonnes with productivity of 527 kg ha^{-1}.The important pulse crops grown in India are bengal gram, lentil, mungbean, black gram, cowpea, red gram, and pea. Among these, mungbean (*Vigna radiata* L. Wilczek) is an ancient and well known leguminous crop of Asia, on account of its nutritional quality and the suitability to cropping system. Mungbean is the third most important pulse crop in India covering an area of 3.53 m. ha with a total production of 1.49 m.t. and the average productivity of 532 kg ha^{-1} (Iranna and Kajjidoni, 2008). Important mungbean growing states in India are Orissa, Andhra Pradesh, Maharastra, Karnataka and Bihar. It is estimated that Indian population will be around 1350 million by 2020 and demand for pulses would further grow in the years to come. The production of pulse crops in India in general and mungbean in particular is not enough to meet the domestic demand of the ever growing population. Hence, there is need to enhance the productivity of mungbean by adopting proper agronomic practices like dates of sowing (Borah, 1997).)and nutrient management apart from evolving new high yielding genotypes.

The production and productivity of mungbean is reported to be low in Northern Transition Zone of Karnataka due to non availability of suitable mungbean genotypes for late *kharif* sown conditions (Parameshwarappa *et al*., 2003). The yield ability of mungbean is mainly dependent on date of sowing. Hence, new genotypes viz., DGGV-2, IPM-02-14 and SEL-4 were evaluated with four dates of sowing to standardize the time of sowing during *kharif* to late *kharif* situation.Apart from this, supplimental nutrition plays a crucial role in increasing seed yield in pulses (Chandrashekar and Bangarusamy, 2003). Foliar application of nutrients is considered an efficient and economic method of supplementing the nutrient requirement of the crop which inturn leads to enhanced yield. In addition, foliar application of nutrients was found to be more advantageous than soil application with the elimination of losses through leaching and fixation. It thus increases photosynthetic rate, better nutrient translocation from the leaves to the developing seeds (Manomani and Srimathi, 2009). Considering the above views and facts the following objectives of investigations were taken. The study was conducted with objectives: 1) To identify the best genotype for sowing in late Kharif, 2) To standardize the suitable date of sowing for obtaining higher yield and quality of mungbean genotype, 3) To study the response of varieties (DGGV-2, IPM-02-14 and SEL-4) to DAP @ 2 % foliar spray

Materials and Methods

A field experiment was carried out during *kharif* season of 2012. The details of materials used and techniques adopted in the present investigation are described below. The experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences in plot number 127 of 'E' block situated at 15°26' N latitude, 75°01' E longitude and at an altitude of 678 m above mean sea level. The Research Station comes under Northern Transition Zone (Zone-8) of Karnataka which lies between the Western Hilly Zone (Zone 9) and Northern Dry Zone (Zone-3).

The annual rainfall received during 2012 was 540.1 mm distributed in 47 rainy days (Table 2). The rainfall during cropping

Table-1: Methods of recording observations on different parameters

Seed yield(kg/ha)	Seed yield per plot was recorded after threshing and winnowing the seeds from each net plot area. The seed yield/ ha was worked out and expressed in kg/ ha.
Haulm yield (kg/ha)	The total biological portion from yield of above ground portion from net plot at harvest was recorded after complete sun drying and haulm yield per ha was worked out by deducting the grain yield.
Plant analysis	
Nitrogen	Nitrogen content in plants was determined by Micro Kjeldahl method expressed in percentage. $\text{N uptake (kg/ha)} = \frac{\text{N concentration in seed(\%) x seed yield (kg/ha)}}{100} + \frac{\text{N concentration in haulm(\%) x haulm yield (kg/ha)}}{100}$
Phosphorous	Phosphorus was estimated by Vanadomolybdate method in tri acid mixture as outlined by Jackson (1967) by using Spectro-photometer at 420 nm and expressed in percentage. $\text{P uptake (kg/ha)} = \frac{\text{P concentration in seed(\%) x seed yield (kg/ha)}}{100} + \frac{\text{P concentration in haulm(\%) x haulm yield (kg/ha)}}{100}$
Potassium	Potassium was estimated by using flame photometer as described by Jackson (1967). $\text{K uptake (kg/ha)} = \frac{\text{K concentration in seed(\%) x seed yield (kg/ha)}}{100} + \frac{\text{K concentration in haulm(\%) x haulm yield (kg/ha)}}{100}$
Quality parameters	
Protein content (%)	Nitrogen content in the grain of black gram was estimated by Kjeldahl method (Jackson, 1967), and the protein per cent in the grain was calculated by multiplying the nitrogen content with a factor 6.25.
Economics	
Cost of cultivation	The prices in rupees of the inputs that were prevailing at the time of their use was considered for working out the cost of cultivation per hectare treatment wise.
Gross return	Gross returns per hectare were derived by taking into consideration the price of the product that was prevailing in market after harvest.
Net return	The net returns per hectare were derived treatment wise by subtracting the total cost of cultivation from gross returns.
Benefit cost ratio	Benefit cost ratio (B: C) was worked out treatment wise as follows: B:C = Gross return (₹ ha^{-1}) / Total cost of cultivation (ha^{-1})

period (June-October) was 424.4 mm which was distributed during crop growth period. It was 24 percent lesser than the normal rainfall (713.8 mm). The rainfall received in the period of first fort night of June to second fort night of July ensured adequate stored moisture for germination, emergence and early establishment of seedlings at first two (I FN of June and II FN of June, respectively) dates of sowing. However the late sown (first fort night July and second fort night of July) crop did not get adequate stored soil moisture during crop growth at different stage. Even though the maximum rainfall in the current year was received in the month of July (112.2 mm) followed by August (90 mm), the distribution of rainfall was erratic. Hence, in delayed sowing dates (I FN of July and II FN of July) crop suffered due to moisture stress during early growth stages.

The soil type of experimental site was medium black clayey. The composite soil sample to a depth of 0-30 cm in the experimental area was collected before sowing and analyzed for important physical and chemical properties. The experimental soils were low in nitrogen (213. 4 kg ha^{-1}, Subbiah and Asija, 1956). Medium in phosphorous (21.50 kg ha^{-1}) and high in potash (325.84 kg ha^{-1}, Jackson 1967). Recommended dose of fertilizer (25:50:0:20 kg ha^{-1} of N: P_2O_5: K_2O: S) was common to all the treatments. The experiment was laid out in split- split plot design with three replications. The experiment had Plot size Gross plot 13.44 m^2 Net Plot 10.08 m². Fertilizers were applied to all the treatments at the rate of 25 kg N and 50 kg P_2O_5 ha^{-1} and 20 kg K_2O ha^{-1} in the form of urea, diammonium phosphate and muriate of potash, respectively. And 20 kg ha^{-1} of sulphur was applied in the form of gypsum. Entire dose of fertilizers was applied as basal. The data collected from the experiment was analyzed statistically following the procedure described by Gomez and Gomez (1984). The level of significance used in 'F' test was P=0.05.

Table-2: Monthly meteorological data during crop growth period (2012) and the average of 62 years (1950-2011) at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad

Months	Rainfall (mm)		Rainy days	Mean Temperature (°C)				Relative humidity (%)	
				Maximum		Minimum			
	2012	1950-2011	(2012)	2012	1950-2011	2012	1950-2011	2012	1950-2011
January	0.0	0.8	0	29.8	28.7	14	14.07	55.55	64.81
February	0.0	11.5	0	32.3	31.6	15.9	16.56	53.46	54.41
March	0.0	1.5	0	35.8	34.9	15.9	19.71	40.74	64.24
April	56.6	48.6	7	35.7	36.6	18.4	20.11	57.10	78.05
May	3.8	20.0	0	35.6	35.2	21.2	20.95	50.84	75.78
June	43.4	106.4	4	30.6	30.2	21.5	21.68	73.7	86.29
July	112.2	153.8	10	27.2	27.3	20.9	20.85	84.6	89.18
August	90.0	101.0	11	32	27.2	19.3	20.16	80.4	88.6
September	89.6	107.5	9	28	27.9	19.8	19.96	75.8	86.68
October	89.2	125.9	4	28.4	29.5	17.8	18.65	64.74	79.4
November	35.7	32.0	1	27.7	28.9	15.5	15.93	57.76	73.62
December	19.6	4.9	1	29.5	27.8	14.8	13.20	55.92	69.12
Total	**540.1**	**713.8**	**47**	-	-	-	-	-	-

Results and Discussion

Seed yield and haulm yield: Mungbean sown on first fort night of June recorded significantly higher seed yield (1268 kg ha^{-1}) when compared to crop sown on second fort night of June (1114 kg ha^{-1}), first fort night July (1009 kg ha^{-1}) and second fort night of July

(898 kg ha^{-1}). The crop sown on first fort night of June registered 12.10 %, 20.43 %, 29.17 % higher yield over second fort night of June, first fort night of July and second fort night of July. The higher seed yield obtained in early sown crop is attributed to higher soil moisture during cropping period as a result of receipt of 112.2 mm rainfall during July. This coincides with the flowering and pod formation stage of early sown crop. These results are in conformity with findings of Chaudhary *et al*. (1994), Singh and Singh (2000). They also observed that early sown crop (6th July) significantly recorded higher leaf area index, dry matter production compared to late sown crop (20th July, 5th August and 20th August, respectively). The yield increase in DAP sprayed crop, was up to 3.96 % as compared to no spray. The above result clearly indicates the importance of inorganic foliar nutrition in determination of yield potential in mungbean. The increased grain yield in mungbean due to beneficial effect of nutrients applied at proper time and stage was also reported by Barik and Rout (1990), Yakadri and Thatikunta (2002) in blackgram, and Srinivasan *et al*. (1992) in cowpea, where foliar application of nutrients at flowering and pod development stage might have been easily absorbed and better trasnslocated in the plant and maintained constant requirement of N and P at the reproductive stage of the crop. The lower yield was obtained with no spray, which attributed to lower availability of nutrients at critical stage i.e. flowering and pod setting stage of the crop, where at these stages crop needs more energy and nutrients for good and proper setting of flowers and pods. Barik and Rout (1990), also found beneficial effects of spraying DAP in black gram (Table-3).

Table-3: Seed yield (kg ha^{-1}) and Haulm yield (kg ha^{-1}) of mungbean genotypes at different growth stages as influenced by dates of sowing and foliar nutrition

Treatment		Seed yield (kg ha^{-1})				Haulm yield (kg ha^{-1})			
Date of	DAP	Genotypes				Genotypes			
sowing (D)	spray	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
D_1 : I FN of June	S_1	1380	1284	1194	1286	2067	1847	2047	1987
	S_2	1327	1245	1176	1249	1835	1762	1906	1834
	Mean	1353	1265	1185	1268	1951	1804	1976	1910
D_2 : II FN of June	S_1	1161	1136	1086	1128	1947	1606	1851	1801
	S_2	1143	1092	1067	1101	1831	1586	1839	1752
	Mean	1152	1114	1077	1114	1889	1596	1845	1777
D_3 : I FN of July	S_1	1072	1009	971	1017	1655	1635	1480	1590
	S_2	1044	972	984	1000	1580	1594	1438	1537
	Mean	1058	991	977	1009	1618	1615	1459	1564
D_4 : II FN of July	S_1	939	1001	892	944	1469	1491	1401	1454
	S_2	836	917	801	852	1448	1455	1356	1419
	Mean	888	959	847	898	1458	1473	1378	1437
Mean of S_1		1138	1036	1056	1094	1784	1695	1599	1708
Mean of S_2		1108	1088	1007	1050	1645	1673	1635	1636
Mean		1113	1082	1021		1729	1622	1665	

Sources	S.Em +	CD (P = 0.05)	S.Em+	CD (P = 0.05)
Date of sowing (D)	12.14	42.00	20.60	71.27
Genotypes (V)	12.26	36.77	27.08	81.19
DAP spray (S)	11.05	32.27	17.44	50.89
D X V	24.53	73.53	54.16	162.38
D X S	22.11	NS	34.87	NS
V X S	19.15	NS	30.20	NS
D X V X S	38.29	NS	60.40	NS

D = Date of sowing: D_1= First fort night of June (14th June) ; D_2= Second fort night of June (29th June); D_3= First fort night of July (15th July); D_4= Second fort night of July (30th July), V= Genotypes: V_1= DGGV-2; V_2= IPM 02-14; V_3= SEL-4
S= DAP Spray: S_1= 2% DAP Spray; S_2= without spray NS= Non Significant

Grain protein content (%): The data on grain protein content (%) of mungbean as influenced by dates of sowing, genotypes and foliar nutrition of 2 % DAP and presented in table-6. There was no significant difference in grain protein content due to the dates of sowing. However, among the mungbean genotypes, significantly higher grain protein content was recorded in DGGV-2 (21.63 %) over IPM-02-14 (21.19 %) and it was on par with SEL-4 (21.32 %). Significant difference was also observed in grain protein content between 2 % DAP spray (21.54 %) and without DAP spray (21.23 %). None of the interactions effects were significant. Higher grain protein content in DGGV 2 (21.63 %) is due to higher nitrogen uptake, because nitrogen is the precursor for protein synthesis these results confirmed with higher grain protein content with foliar application of DAP 2 % is associated with higher uptake of nitrogen (Tripathi *et al* 1998).

Total nutrient uptake of mungbean (at harvesting stage)

Nitrogen uptake : The data on nitrogen (N) uptake at harvesting stage as influenced by dates of sowing, genotypes and foliar nutrition of 2 % DAP spray are presented in table-4. There was significant difference in nitrogen uptake among different dates of sowing. Maximum nitrogen uptake was recorded in early sown crop, on first fort night of June (56.44 kg ha^{-1}), followed by second fort night of June (48.12 kg ha^{-1}) compared to first fort night of July (38.72) and second fort night of July (32.51 kg ha^{-1}). The genotype DGGV-2 registered significantly higher nitrogen uptake (48.31 kg ha^{-1}) over IPM-02-14 (40.81 kg ha^{-1}) and SEL-4 (42.72 kg ha^{-1}). There was a significant difference observed in nitrogen uptake with 2 % DAP spray (46.82 kg ha^{-1}) as compared to no spray (41.07 kg ha^{-1}). None of the interaction effects were significant except dates of sowing and variety. The interaction D_1V_1 (first fort night of June and DGGV-2) recorded significantly higher nitrogen uptake (61.70 kg ha^{-1}) as compared to other treatment combinations and it was on par with D_2V_1 (57.04 kg ha^{-1}). However, the lower nitrogen uptake was recorded in D_4V_3 (28.08 kg ha^{-1}). Significantly higher N P and K uptake were observed in the early sown crop on first fort night of June over second fort night of June, first fort night of July and second fort night of July. This is mainly attributed to higher biomass production (seed and haulm yield) by the early sown crop over the late sown crop. These results are in agreement with the findings of Chaudhary *et al.* (1988). They reported that black gram sown on 6th July recorded higher dry matter production and partitioning compared to 20th July 5th august and 20th August.

Phosphorous uptake (kg ha^{-1}): The data on phosphorous uptake at harvesting stage in relation to dates of sowing, genotypes and foliar nutrition of 2 % DAP are presented in table-4. There was significant difference in phosphorous uptake among different dates of sowing. Maximum phosphorous uptake at harvesting stage was recorded in the early sown crop, on first fort night of June (10.16 kg ha^{-1}), followed by second fort night of June (9.32

Table-4: N, P and K uptake (kg ha^{-1}) of mungbean genotypes at harvest as influenced by dates of sowing and foliar nutrition

Treatment		N Uptake (kg ha^{-1})				P Uptake (kg ha^{-1})				K Uptake (kg ha^{-1})			
Date of sowing (D)	DAP spray	Genotypes				Genotypes				Genotypes			
		V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
D_1 : I FN of June	S_1	67.06	54.53	59.14	60.24	12.12	10.38	10.21	10.91	28.74	23.43	25.66	25.94
	S_2	56.34	50.47	51.10	52.64	10.66	8.30	9.28	9.41	25.61	20.28	21.46	22.45
	Mean	61.70	52.50	55.12	56.44	11.39	9.34	9.75	10.16	27.17	21.85	23.56	24.20
D_2 : II FN of June	S_1	60.89	41.25	51.31	51.15	9.49	8.69	12.02	10.07	23.05	21.78	24.61	23.14
	S_2	53.18	37.38	44.69	45.09	8.34	7.48	9.88	8.57	21.22	18.85	21.96	20.68
	Mean	57.04	39.32	48.00	48.12	8.92	8.09	10.95	9.32	22.13	20.31	23.29	21.91
D_3 : I FN of July	S_1	43.30	38.45	41.08	40.94	10.62	8.66	9.33	9.54	21.13	19.06	16.11	18.77
	S_2	37.77	33.44	38.27	36.49	9.87	8.23	7.81	8.64	18.46	17.45	18.33	18.08
	Mean	40.53	35.94	39.67	38.72	10.25	8.44	8.57	9.09	19.80	18.26	17.22	18.42
D_4 : II FN of July	S_1	37.18	37.11	30.58	34.96	7.89	8.94	7.08	7.97	15.93	18.25	15.67	16.62
	S_2	30.78	33.85	25.57	30.07	6.97	7.67	5.17	6.60	14.81	16.33	11.81	14.32
	Mean	33.98	35.48	28.08	32.51	7.43	8.31	6.13	7.29	15.37	17.29	13.74	15.47
Mean of S_1		52.11	45.53	38.79	46.82	10.03	9.66	7.92	9.62	22.21	20.51	18.23	21.12
Mean of S_2		42.84	44.52	39.91	41.07	9.17	8.96	8.04	8.31	20.63	20.02	18.39	18.88
Mean		48.31	40.81	42.72		9.49	8.54	8.85		21.12	19.43	19.45	

Sources	S.Em+	CD (P = 0.05)	S.Em+	CD (P = 0.05)	S.Em+	CD (P = 0.05)
Date of sowing (D)	0.92	3.18	0.19	0.67	0.43	1.49
Genotypes (V)	0.92	2.76	0.19	0.56	0.43	1.30
DAP spray (S)	0.61	1.79	0.13	0.39	0.30	0.89
D X V	1.84	5.52	0.38	1.13	0.87	2.59
D X S	1.22	NS	0.27	NS	0.61	NS
V X S	1.06	NS	0.23	NS	0.53	NS
D X V X S	2.12	NS	0.46	NS	1.05	NS

Table-5: Gross Returns, Net returns, benefit cost ratio of mungbean genotypes at flowering stages as influenced by dates of sowing and foliar nutrition

Treatment		N Uptake (kg ha^{-1})				P Uptake (kg ha^{-1})				K Uptake (kg ha^{-1})			
Date of sowing (D)	DAP spray	Genotypes				Genotypes				Genotypes			
		V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
D_1 : I FN of June	S_1	53355	49634	46286	49758	36553	32832	29484	32956	3.18	2.95	2.75	2.96
	S_2	51257	48098	45540	48298	34455	31296	28738	31496	3.05	2.86	2.71	2.87
	Mean	52306	48866	45913	49028	35504	32064	29111	32226	3.11	2.91	2.73	2.92
D_2 : II FN of June	S_1	44990	43896	42106	43664	28188	27074	25304	26855	2.68	2.61	2.51	2.60
	S_2	44261	42192	41372	42608	27459	25390	24570	25806	2.63	2.51	2.46	2.54
	Mean	44625	43044	41739	43136	27823	26232	24937	26331	2.66	2.56	2.48	2.57
D_3 : I FN of July	S_1	41462	39093	37547	39367	24660	21991	20445	22365	2.47	2.29	2.20	2.32
	S_2	40380	37648	38038	38689	23278	20546	20936	21587	2.36	2.20	2.22	2.26
	Mean	40921	38371	37792	39028	23969	21269	20690	21976	2.41	2.24	2.21	2.29
D_4 : II FN of July	S_1	36353	38695	34523	36524	19251	21593	17421	19422	2.13	2.26	2.02	2.14
	S_2	32419	35510	31067	32999	15317	18408	13965	15897	1.90	2.08	1.82	1.93
	Mean	34386	37102	32795	34761	17284	20000	15693	17659	2.01	2.17	1.92	2.03
Mean of S_1		44040	40115	40862	42328	27163	23163	23910	25400	2.61	2.37	2.41	2.50
Mean of S_2		42830	42079	39004	40649	25873	25127	22052	23697	2.53	2.49	2.30	2.40
Mean		43060	41846	39560		26145	24891	22608		2.55	2.47	2.34	

Sources	S.Em+	CD (P = 0.05)	S.Em+	CD (P = 0.05)	S.Em+	CD (P = 0.05)
Date of sowing (D)	0.92	3.18	0.19	0.67	0.43	1.49
Genotypes (V)	0.92	2.76	0.19	0.56	0.43	1.30
DAP spray (S)	0.61	1.79	0.13	0.39	0.30	0.89
D X V	1.84	5.52	0.38	1.13	0.87	2.59
D X S	1.22	NS	0.27	NS	0.61	NS
V X S	1.06	NS	0.23	NS	0.53	NS
D X V X S	2.12	NS	0.46	NS	1.05	NS

D = Date of sowing: D_1= First fort night of June (14th June); D_2= Second fort night of June (29th June); D_3= First fort night of July (15th July); D_4= Second fort night of July (30th July), V= Genotypes: V_1= DGGV-2; V_2= IPM 02-14; V_3= SEL-4, S= DAP Spray: S_1= 2% DAP Spray; S_2= without spray NS= Non Significant

Table-6: Protein content (%) of mungbean genotypes at different growth stages as influenced by dates of sowing and foliar nutrition

Treatment Date of sowing (D)	DAP spray	Protein content (%) Genotypes V_1	V_2	V_3	Mean
D_1 : I FN of June	S_1	22.20	21.53	21.24	21.66
	S_2	21.15	20.56	20.84	20.85
	Mean	21.67	21.04	21.04	21.25
D_2 : II FN of June	S_1	21.92	21.24	21.98	21.71
	S_2	21.35	21.40	21.40	21.38
	Mean	21.63	21.32	21.69	21.55
D_3 : I FN of July	S_1	21.84	21.53	21.42	21.60
	S_2	21.64	20.61	21.77	21.34
	Mean	21.74	21.07	21.60	21.47
D_4 : II FN of July	S_1	21.29	21.10	21.16	21.18
	S_2	21.69	21.58	20.73	21.33
	Mean	21.49	21.34	20.95	21.26
Mean of S_1		21.81	21.45	21.03	21.54
Mean of S_2		21.35	21.46	21.19	21.23
Mean		21.63	21.19	21.32	
Sources	**S.Em+**	**CD (P = 0.05)**			
Date of sowing (D)	0.11	NS			
Genotypes (V)	0.11	0.34			
DAP spray (S)	0.09	0.26			
D X V	0.23	NS			
D X S	0.18	NS			
V X S	0.15	NS			
D X V X S	0.31	NS			

D = Date of sowing: D_1= First fort night of June (14th June); D_2= Second fort night of June (29th June); D_3= First fort night of July (15th July); D_4= Second fort night of July (30th July), V= Genotypes: V_1= DGGV-2; V_2= IPM 02-14; V_3= SEL-4, S= DAP Spray: S_1= 2% DAP Spray; S_2= without spray NS= Non Significant

kg ha^{-1}) compared to first fort night of July (9.09 kg ha^{-1}) and second fort night of July (7.29 kg ha^{-1}). The genotype DGGV-2 registered significantly higher phosphorous uptake (9.49 kg ha^{-1}) over IPM-02-14 (8.54 kg ha^{-1}) and SEL-4 (8.85 kg ha^{-1}). There was a significant difference observed in phosphorous uptake in 2 % DAP spray (9.62 kg ha^{-1}) compared to without DAP spray (8.31 kg ha^{-1}). Spraying of 2 % DAP at 30 and 45 DAS recorded significantly higher seed yield (1094 kg ha^{-1}) over no spray (1050 kg ha^{-1}). The increased seed yield with 2 % DAP was mainly due to the increased nutrient supply and reduced nutrient losses. Spraying of 2 % DAP at 30 and 45 DAS perhaps helped in quick absorption of nitrogen and phosphorous, at the time of reproductive stage where the nutrient demand is at the peak due to indeterminate growth habit of the crop. Hence it reduced the flower drop and ultimately enhanced the pod setting and resulted in higher seed yield. The results are corroborating with the findings of Revathy *et al.* (1997), Dixit and Elamathi (2007). The interaction D_1V_1 (first fort night of June and DGGV-2) recorded significantly higher phosphorous uptake (11.39 kg ha^{-1}) as compared to other treatment combinations. However, it was on par with D_2V_3 (10.95 kg ha^{-1}). The lowest phosphorous uptake was recorded in D_4V_3 (6.13 kg ha^{-1}).

Potassium uptake (kg ha^{-1}): The data on Potassium uptake at harvesting stage as influenced by dates of sowing, genotypes as and foliar nutrition of 2 % DAP are presented in table-4. There was significant difference in potassium uptake among different dates of sowing. Maximum potassium uptake was recorded in the early sown crop, on first fort night of June (24.20 kg ha^{-1}), followed by second fort night of June (21.91 kg ha^{-1}) compared to first fort night of July (18.42 kg ha^{-1}) and second fort night of July (15.47 kg ha^{-1}). The genotype DGGV-2 registered significantly higher potassium uptake at harvesting stage (21.12 kg ha^{-1}) over IPM-02-14 (19.43 kg ha^{-1}) and SEL-4 (19.45 kg ha^{-1}). Potassium uptake at harvesting stage in 2 % DAP spray (21.12 kg ha^{-1}) was significantly higher compared to without DAP spray (18.88 kg ha^{-1}) differed significantly. The interaction D_1V_1 (first fort night of June and DGGV-2) recorded significantly higher potassium uptake (27.17 kg ha^{-1}) as compared to other treatment combinations. However, the lower K uptake was observed in D_4V_3 (13.74 kg ha^{-1}). Improved yield and growth attributes might be interpreted as the manifestation of higher nutrient uptake at harvesting stage by the plants. The higher nitrogen uptake was recorded with DAP at 2 % spray (46.82 kg ha^{-1}) as compared to no spray (41.07 kg ha^{-1}). The increased N uptake with DAP sprayed treatment might be attributed to quick and easy absorption and translocation of nutrients in the plant system without any loss. Similar findings were also observed by Elayaraja and Angayarkanni (2005) foliar application of DAP 2% at 20, 30 and 45 DAS resulted in higher NPK uptake in both seed (43.03, 46.22 and 6.85 kg ha^{-1}, respectively) and haulm (5.39, 8.18 and 15.01 kg ha^{-1}, respectively) of blackgram. Further, the foliar application of DAP at 2 per cent spray at 30 and 45 DAS resulted in higher phosphorus and potash uptake (9.62, 21.12 kg ha^{-1}) (Table 3), as compared to no spray (8.31, 18.88 kg ha^{-1}). The increased phosphorous uptake might be due to substantial increase in available P and K in soil. Higher nutrient uptake in foliar spray treatment could be attributed to increased nutrient availability in the soil. The foliar spray of DAP at 2 per cent increased availability. Elayaraja and Angayarkanni (2005) also observed higher N, P and K uptake in black gram due to foliar spray of at 2 per cent DAP.

Economics: The data on gross return, net return and B: C ratio are presented in table-5.

Gross returns (₹ ha^{-1}): The gross return was realized in the crop sown during first fort night of June was significantly higher (₹ 49028 ha^{-1}) followed by second fort night of June (₹ 43136 ha^{-1}) compared to first fort night of July (₹ 39028 ha^{-1}) and second fort night of July (₹ 34761 ha^{-1}). However among the mungbean genotype DGGV-2 (₹ 43060 ha^{-1}) gave significantly higher gross return and it was on par with IPM-02-14 (₹ 41846 ha^{-1}) over SEL-4 (₹ 39560 ha^{-1}). Similarly, significant difference in gross return was observed with 2 per cent DAP spray (₹ 42328 ha^{-1}) as compared to no spray (₹ 40649 ha^{-1}).

The gross return of mungbean was significantly influenced by dates of sowing, genotypes, and foliar nutrition. Among the treatment combinations, genotype DGGV-2 sown on first fort night of June with 2 per cent DAP at 30 and 45 DAS recorded significantly higher gross return (₹ 52419 ha^{-1}) over the other treatment combinations. However, it was on par with the crop sown on first fort night of June with DGGV-2 and without spray (₹ 50119 ha^{-1}) and variety IPM-02-14 sown on first fort night of June of with 2 per cent DAP spray. The lower gross return (₹ 48645 ha^{-1}) was observed in crop sown on second fort nigh of July with SEL-4 and without DAP spray.

Net return (₹ ha^{-1}): Significantly higher net return was recorded in first fort night of June (₹ 32226 ha^{-1}) followed by second fort night of June (₹ 26331 ha^{-1}) compared to first fort night of July (₹ 21976 ha^{-1}) and second fort night of July (₹ 17659 ha^{-1}). Among the genotypes DGGV-2 (₹ 26145 ha^{-1}) gave significantly higher net return which was on par with IPM-02-14 (₹ 24891 ha^{-1}) over SEL-4 (₹ 22608 ha^{-1}). Further there was a significant difference observed in 2 per cent DAP spray (₹ 25400 ha^{-1}) over no spray (₹ 23697 ha^{-1}) in terms of net return. The net return of mungbean was significantly influenced by the dates of sowing, genotypes, and foliar nutrition. Among the treatment combinations tried, the genotype DGGV-2 sown on first fort night of June with 2 per cent DAP spray at 30 and 45 DAS recorded significantly higher net returns (₹ 41954) over other treatment combinations. However, it was on par with the crop sown on second fort night of June with DGGV-2 and without spray (₹ 39634) and genotype IPM-02-14 sown on first fort night of June with 2 per cent DAP spray. The lower net return of mungbean noticed (₹ 38147) in crop sown on second fort night of July with SEL-4 without spray.

Benefit cost ratio: Significantly higher B: C ratio was recorded in first fort night of June (2.92) followed by second fort night of June (2.57), first fort night of July (2.29) and second fort night of July (2.03). Among the genotypes DGGV-2 (2.55) gave significantly higher B: C ratio which was on par with IPM-02-14 (2.47) over SEL-4 (2.34). The B:C ratio was also significantly different in 2 per cent DAP spray (2.50) over no spray (2.40). None of the interactions were significant. The B: C ratio of mungbean differed significantly due to different dates of sowing, genotypes and foliar nutrition. The crop sown on first fort night of June with variety DGGV-2 and 2 per cent DAP spray recorded significantly higher B: C ratio (3.18) compared to other treatment interactions. It was on par with first fort night of June with variety DGGV-2 and without spray, first fort night of June with variety IPM-02-14 and 2 per cent DAP spray. However, lower B: C ratio was recorded in SEL- 4 variety (1.82) sown on second fort night of July without DAP spray.

From the present study, it may be concluded that-

* In the present investigation early sowing (first fort night of June) of mungbean recorded significantly higher seed yield (1268 kg ha^{-1}) over late sown condition (second fort night of July). The increase was 29.17 per cent higher in (first fort night of June).
* Nitrogen uptake at flowering stage (59.02 kg/ha) was significantly higher in early sown crop (first fort night of June) compared to other dates of sowing. Similar trend was also observed in case of P and K at flowering and harvesting stages.
* Spraying of 2 per cent DAP at 30 and 45 DAS recorded significantly higher seed yield (1094 kg ha^{-1}) over no spray (1050 kg ha^{-1}).
* Early sowing of (first fort night of June) of mungbean genotype DGGV-2 recorded higher seed yield (1353 kg ha^{-1}) followed by (first fort night of June) sown + IPM-02-14 (1265 kg ha^{-1}). Significantly lower seed yield (847 kg ha^{-1}) was recorded with late sowing of mungbean (second fort night of July + SEL-4).
* Among the interaction effects, (first fort night of June) + DGGV-2 significantly recorded higher total uptake of nitrogen (61.70 kg ha^{-1}), phosphorous (11.39 kg ha^{-1}), potassium (27.17 kg ha^{-1}). Significantly lower uptake of N (25.57 kg ha^{-1}), P_2O_5 (5.17 kg ha^{-1}), K_2O (11.81 kg ha^{-1}) was recorded with (second fort night of July) + SEL- 4 at harvesting stage.
* Higher net returns were recorded with (first fort night of June) + DGGV-2 at 30 and 45 days after sowing (35504 ha^{-1}). The higher benefit cost ratio was observed with first fort night of June) + DGGV-2 over other treatment combinations.

Mungbean genotype DGGV-2 sown during first fort night of June provided with 2 % DAP spray, recorded the higher seed yield (1380 kg ha^{-1}) and net returns (35504 ha^{-1}) over other varieties and dates of sowing. Under late sown conditions, DGGV-2 and IPM-02-14 recorded significantly higher yield (1114 and 1082 kg ha^{-1}, respectively) and net returns of (26145 and 24891 ha^{-1}) over SEL-4.

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